Swietenia macrophylla King Honduras mahogany, caoba

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Meliaceae Mahogany family

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Swietenia macrophylla King, commonly known as Honduras or bigleaf mahogany (English) and caoba (Spanish), is a large tree, often growing to more than 30 m in height and 1.5 m in trunk diameter. The dark-green leaves are pinnately compound, and the bole is covered with rough, gray-brown bark 1 to 1.5 cm thick (fig. 1). The light, reddish-brown heartwood, which ages to a golden brown, has a fine, uniform texture and an attractive figure. It is one of the easiest woods to work, takes an excellent finish, and is considered by many to be the world's premier cabinet wood (*36*). There are three recognized species of *Swietenia: S. macrophylla, S. mahagoni,* and *S. humilis.*

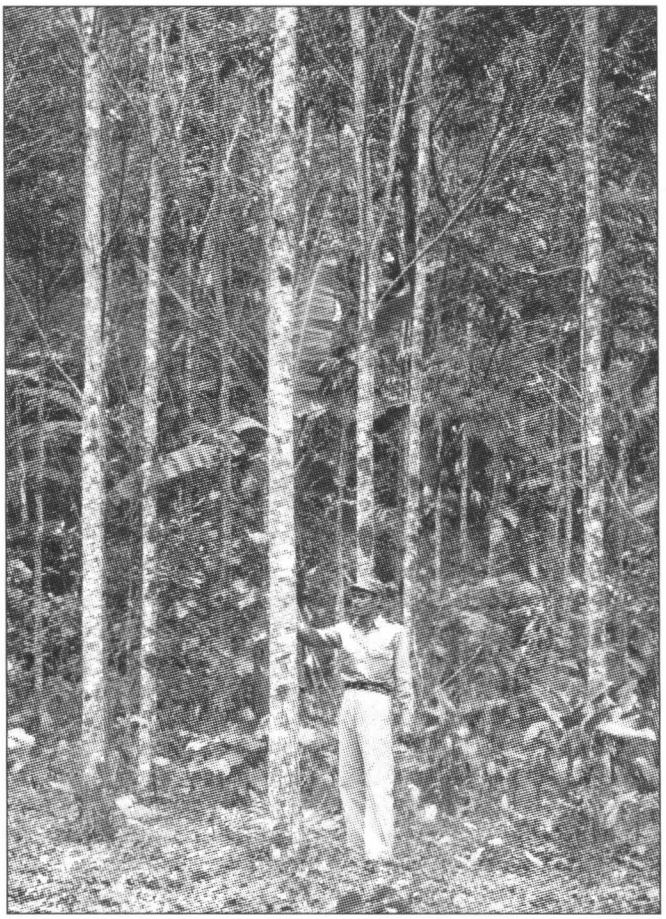

Figure 1.—*Eleven-year-old plantation of Honduras mahogany (*Swietenia macrophylla *King) growing in Puerto Rico.*

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HABITAT

Native and Naturalized Range

Honduras mahogany has the widest distribution of the three *Swietenia* species. It grows naturally from 23° N. to slightly below 18° S. latitude in the neotropics (*30, 33*) (fig. 2). It is native to Mexico in North America and Belize, Honduras, Guatemala, Nicaragua, Costa Rica, and Panama in Central America. In South America, it is native to Venezuela, Colombia, Ecuador, Peru, Brazil, and Bolivia.

Because of its well-established market value and ability to adapt to a variety of site conditions, Honduras mahogany has been planted extensively throughout the world, both within and outside its native range. It has been planted in "close plantations," or open-field plantations, on deforested areas and abandoned farm land, and in enrichment or line plantings below a degraded forest canopy (*3, 7, 8, 9, 11, 18, 28, 40, 42, 43, 44, 47, 49, 50, 56, 57, 64, 66*). Honduras mahogany has been planted on almost every island in the West Indies. It was introduced in Puerto Rico about 1906 (*23*) and has since become naturalized.

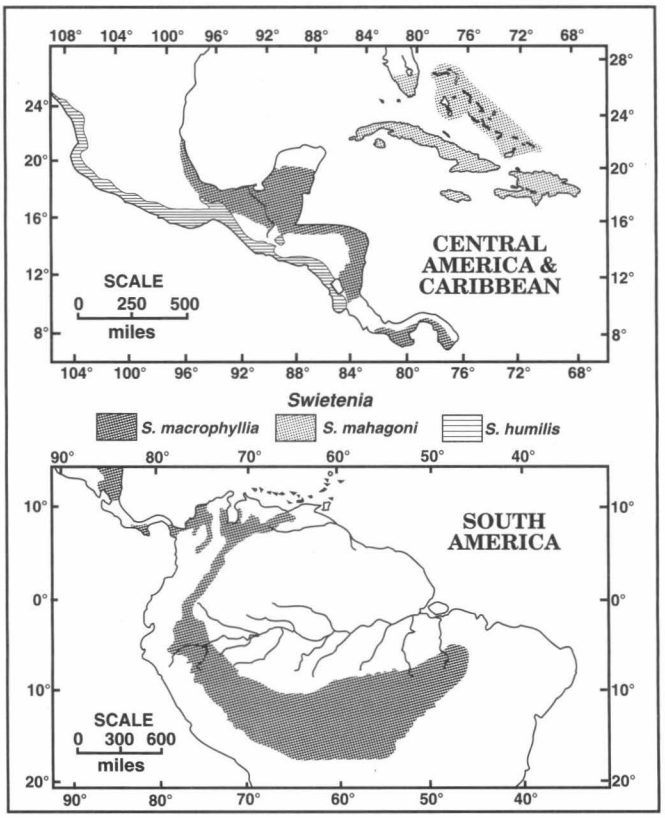

Figure 2.—*Natural ranges of Honduras mahagony (*Swietenia macrophylla *King) and two other species of* Swietenia *in the neotropics.*

Climate

Honduras mahogany grows best and attains its largest size under the climatic conditions found in the tropical dry forest life zone. This life zone is limited by a mean annual temperature of 24 °C or higher, a mean annual precipitation of 1000 to 2000 mm, and a potential evapotranspiration ratio of between 1.00 and 2.00. Under certain ecological conditions, Honduras mahogany extends into the tropical moist life zone, which is limited by a mean annual temperature of 24 °C or higher, a mean annual precipitation of between 2000 and 4000 mm, and a potential evapotranspiration ratio of between 0.50 and 1.00. Additionally, the species probably extends into the transition between the two above-mentioned life zones and the subtropical dry forest and subtropical moist forest life zones (*33*). The optimum growth of Honduras mahogany in Puerto Rico is reported to occur in areas that receive 1900 mm or more of annual rainfall (*25*).

Soils and Topography

Honduras mahogany has adapted to a wide range of soil conditions. Within its natural range, it grows on alluvial soils of mixed origin, volcanic soils, and soils derived from limestone, granite, andesite, and other sedimentary, igneous, and metamorphic rocks (*33*). Under plantation conditions, it has shown satisfactory growth on eroded, phosphorous-deficient soils in West Java (*14*); poor, gravelly laterite soils formed by the decomposition of gneiss in Sri Lanka (*33*); disintegrated (but not bare) laterite soils in India (*61*); andic soils in Fiji and the Philippines (*7, 11*); deep, acid clays in Puerto Rico (*42*) and Peru; and clay soils derived from limestone in Puerto Rico. In Honduras, it has been successfully planted in every soil texture from sand to heavy clay, and it has shown satisfactory results in poorly drained areas where other species have failed. The best results for this species in Honduras have been obtained when it was planted on well-drained alluvial loams (*9*).

Associated Forest Cover

Honduras mahogany grows in association with many species across its broad range. For example, in Chiapas, Mexico, it is found growing in an evergreen hardwood forest dominated by *Dialium* spp. with the notable associates *Alchornea latifolia* Sw., *Ampelocera hottlei* (Standl.) Standl., *Drypetes brownii* Standl., *Ficus* spp., *Guarea glabra* Vahl, *Guatteria anomala* R.E. Fries, *Licania platypus* (Hemsl.) Fritsch., *Manilkara zapota* (L.) V. Royen, *Mirandaceltis monoica* (Hemsl.) Sharp, *Pithecellobium arboreum* (L.) Urban, *Poulsenia armata* (Miq.) Standl., *Pouteria sapota* (Jacq.) H.E. Moore & Stearn, *Quararibea funebris* (Llave) Vischer, *Sapium* sp., and *Varairea laundellii* (Standl.) Killip (*54*). In Petén, Guatemala, in a forest dominated by *Manilkara zapota*, tree associates include Honduras mahogany, *Aspidospera magalocarpon* Muell. Arg., *Astronium graveolens* Jacq., *Brosimum alicastrum* Sw., *Calophyllum brasiliense* Jacq., *Cedrela odorata* L., *Guatteria glabra*, and *Vitex gaumerri* Greenm. (*24*). Near the southern end of the range in the Río Tambo drainage in Peru, Honduras mahogany is associated with the following genera: *Aniba, Brosimum, Caryocar, Cedrela, Cedrelinga, Clarisia, Juglans, Podocarpus,* and *Virola* (*46*).

LIFE HISTORY

Reproduction and Early Growth

Flowering and Fruiting.—Flower clusters (panicles), 10 to 15 cm or more in length, form in Honduras mahogany at the base of new leaves. The clusters bear many small, short-stalked, fragrant, greenish-yellow flowers nearly 1 cm across. The flower contains 5 petals, 10 tiny brown stamens, and a pistil with a 5-celled ovary. A few flowers have parts in four or multiples of four (*36*).

The genus *Swietenia* is monoecious with structurally perfect but functionally imperfect flowers. Trees bear both functionally staminate and functionally pistillate flowers, usually in different inflorescences (*35, 72*). It is believed that Meliaceae is pollinated primarily by bees and moths (*59*).

Honduras mahogany produces large egg- or pear-shaped capsules (about 15 cm long and 9 cm broad at the widest area). These are borne on long, stout stalks (*31*). The fruit capsules have a thick-walled, rough, brownish pericarp (*36*). The pericarp is composed of five fused carpels that are clearly delineated on the surface by slightly paler lines. Prior to dehiscence, an abscission layer is formed across the fruit stalk depriving it of its water supply. This causes the fruit to split open. Splitting occurs along the pericarp boundaries from the middle of the fruit downward. The pericarp splits into five outer and five inner segments. The outer segments remain attached to the top of the fruit for a short time and eventually fall off, exposing the white inner pericarp segments, which in turn fall off.

Internally, the fruit capsule is composed of a woody placenta divided into 5 loculi, each of which contains from 10 to 16 winged seeds arranged symmetrically in 2 rows (*31*). The winged seeds measure 8 to 9 cm in length and 2.0 to 2.5 cm in width (*36*). The papery wing attaches to the placenta and hangs downward. The length of the seed varies, thus allowing each seed to fit exactly above the bulge of the seed below so that the surface is smooth and compact. The seeds are white and succulent when immature, but by the time dehiscence occurs, all the appendages are the characteristic mahogany-brown color. After the pericarp drops, the mature seeds hang away from the placenta at an inclined angle from their attachment at the top and soon detach from their fragile attachment (*31*).

Under favorable conditions, Honduras mahogany may begin flowering by 12 years of age (*33*). The time of year that flowering and fruiting occur varies, coinciding with the incidence of dry weather. Dry, windy weather provides ideal conditions for the opening of the mature fruit and dispersal of the seeds along with dispersal of the flower pollen. In any specific location, the flowering and fruiting may vary by as much as a month from one year to another as the dry season fluctuates (*33*).

Observations from Mexico to Colombia and Venezuela record Honduras mahogany flowering and fruiting from December to May (*1, 32, 39, 53*). On Panama's Pacific coast, in the region of the Canal Zone, flowering and fruiting have been recorded from late December to early January (*33*). In the Amazon region of Peru, where the dry season lasts from July to October, flowering takes place in September or October, with the fruit maturing in the following year (*70*). A more recent study near Pucallpa, Peru, reported that flow-

ering occurs from August to mid-October, with mature seeds disseminating from April to September (*16*).

In areas where Honduras mahogany has been introduced, flowering and fruiting occur during the dry season (*33*). In the Philippines, Honduras mahogany flowers from March to April and produces mature seeds from December to February (*11*). In Martinique, seed production occurs from January to April (*40*). In Puerto Rico, it has been reported that flowering proceeds from May to June, with mature seed production taking place "late in fall" (*36*). It has been observed that, in the subtropical wet forest life zone in the Luquillo Experimental Forest and elsewhere in Puerto Rico, seed release is most frequent from February to March, although individual trees have been seen with mature fruits throughout the year.

Seed Production and Dissemination.—The quantity of seeds produced varies considerably from tree to tree and from year to year, probably in response to growing conditions (authors, personal observation). However, except for an occasional year when only a few fruits develop, Honduras mahogany can be classified as an abundant seed producer (*33*). In Puerto Rico, it is common for individual trees to produce more than 150 fruit capsules, each containing from 50 to 70 seeds. In the Philippines, as many as 210 fruit capsules, with 57 to 64 seeds each, have been observed on individual trees (*11*).

Honduras mahogany seed size varies among geographic locations (*33*) and also among individual trees and fruits. Samples from Venezuela averaged 1,323 seeds per kilogram; from Panama, 1,984 seeds per kilogram; from Nicaragua, 1,433 seeds per kilogram; from Honduras, 2,072 seeds per kilogram; and from Guatemala (Pacific coast), 1,543 seeds per kilogram (*33*). In other studies, it has been reported that seeds (with wings attached) from Alexander Von Humboldt National Forest in Peru averaged 1,242 seeds per kilogram (*62*), dewinged seeds from Belize averaged 2,100 seeds per kilogram (*69*), and dewinged and air-dried seeds from Puerto Rico stored under refrigeration averaged 1,724 seeds per kilogram, whereas similar seeds stored at room temperature averaged 1,852 seeds per kilogram (*2*). In a recent study in Puerto Rico, individual seed weight (dewinged and dried) for stored seeds varied from 0.33 to 0.91 g for refrigerated seeds and from 0.21 to 0.72 g for seeds at room temperature (*2*).

Wind is the most important seed dispersal agent. A large tree disperses its seeds over an area of about 4 ha on the leeward side. Since seed dispersal occurs just before the rainy season, it is probable that flood waters play an important role in seed dispersal in some areas. Mammals and birds are not known to be important factors in dispersal. However, they sometimes eat and destroy the seeds, thus preventing their spread (*33*).

Seedling Development.—Honduras mahogany seeds will germinate as soon as they are mature if edaphic conditions are favorable (*33*). In Puerto Rico, seeds have been observed germinating in fresh fruit capsules on the ground. In tree nurseries, seeds may begin to germinate as soon as 10 days after sowing (*33*), but, generally, germination does not begin until 15 to 24 days after sowing. Germination is usually complete in about 20 to 30 days but may continue for 65 to 70 days (*2, 26, 33, 45, 62, 63*). In Puerto Rico, a study of 448 seeds showed that the highest rate of germination occurred between 16 to 20 days after sowing (61.7 percent for seeds stored under refrigeration and 44.1 percent for seeds stored at room temperature) and that about 95 percent of all seeds were germinated by 30 days after sowing (*2*). Germination is influenced by: (1) seed age (fresh seeds germinate more quickly and with a higher percentage), (2) sowing depth (2 to 5 cm is generally the recommended depth), (3) soil strata (well-drained soils are best), (4) moisture supply (should be abundant), (5) temperature, and (6) planting position (*2, 26, 33, 45, 62, 63*).

A study on survival of young nursery-grown Honduras mahogany in Puerto Rico showed a seedling survival rate of at least 90 percent at 6 months of age and 87 percent at 12 months of age from seeds that had been dried and stored for 6 months (*2*). The difference was not statistically significant. In other studies, survival has been shown to be influenced by the seeds' sowing position (*29*) and freshness (*26*).

In nursery-grown seedlings, growth varies considerably with the quality of the nursery site and the time of year (*25*). Where full light, well-drained soil, and an abundant water supply are provided, growth is rapid, and seedlings reach a height of 60 to 90 cm in 6 months (*33*). In Puerto Rico, seedlings grown in a nursery reached heights of about 31 cm in 4 months and 61 cm in 6 months (*25*). Another nursery study in Puerto Rico showed seedlings grown in unfertilized clay soil reached an average height of about 11 cm in 3 months, 14 cm in 6 months, and 71 cm in 12 months. This same study showed no significant differences in height growth between seeds stored under refrigeration and those stored at room temperature at 3 and 6 months of age. However, there was a significant difference in height growth by the time seedlings were 12 months of age, with seedlings from refrigerated seeds growing significantly taller than seedlings from seeds stored at room temperature. Also, a comparison of seedling height at 12 months of age to original seed weight showed no correlation between these two parameters (*2*). Under forest conditions, seedling growth is much slower than in the nursery, with heights of about 15 cm reached in 6 months to a year (*33*).

Vegetative Reproduction.—Hondorus mahogany can be propagated by cuttings in the nursery. A low percentage of woody cuttings will root in moist soil without any treatment (*73*). Seventy-percent rooting was achieved with woody cuttings 25 cm long and 5 cm in diameter treated with IBA (indolbuteric acid) (*6*). Honduras mahogany saplings, poles, and small sawlog trees coppice when cut.

Sapling and Pole Stage to Maturity

Growth and Yield.—Diameter and volume growth rates of individual Honduras mahogany trees are impressive, but yields per area are less impressive due to the moderate basal areas maintained by the species. Trees in a small plantation in Peru reached heights of 6.5 m in 3 years, 9.3 m in 5 years, and 11.4 m in 7 years (*6*). In a high rainfall area of Sri Lanka, a 15-year-old planting reached a height of 16 m, and another extensive plantation reached a mean diameter at breast height (d.b.h.) of 58 cm in 50 years (*58*). The best seed sources (Nicaragua) of a provenance trial in Puerto Rico averaged 21 to 23 m in height and 26 cm in d.b.h. when 20 years old (*22*). In another plantation of Honduras mahogany in Puerto Rico, four plots 23 to 26 years old had a mean annual d.b.h. increment of 0.94 ± 0.01 cm/yr (*19*). Several hundred hectares of 50-year-old Honduras mahogany plantations in the

Luquillo Experimental Forest in Puerto Rico support an average basal area of 21 m^2/ha, of which Honduras mahogany comprises from a small part to nearly all the basal area. General productivity figures for this species have been given as 7 to 11 m^3/ha/yr (*67*). A site index table and models for predicting yields based on site index and age are available for Honduras mahogany in the Philippines (*52*). The U.S. Department of Agriculture, Forest Service, projects rotation periods of 40 to 60 years for the species in the Luquillo Experimental Forest in Puerto Rico.

Rooting Habit.—As a seedling, Honduras mahogany produces a strong taproot. It adds many fine lateral roots that gradually thicken to form an extensive lateral root system. Older trees develop small- to medium-sized buttresses. Lateral roots of large trees are exposed for a meter or more on wet sites and clayey soils.

Reaction to Competition.—Honduras mahogany, classified as an intolerant species, cannot survive deep shade. In the weak light under a dense tropical forest canopy, Honduras mahogany seedlings that do germinate usually fail to survive more than a few months. Under filtered light, seedlings may persist for many years, growing slowly in a suppressed condition. The most rapid growth is attained under complete sunlight with side protection. Seedlings respond rapidly to release from undergrowth and the overhead canopy (*33*). Mahogany plantations were shown to cycle nutrients efficiently and supported almost as many understory species as adjacent natural secondary forests (*38*).

Damaging Agents.—By far the most serious problem of Honduras mahogany grown in plantations is the mahogany shoot borer, *Hypsipyla grandella* Zeller. Attacking seedlings and saplings, it rarely kills a tree, but resprouting after attacks results in serious degrading of form (*68*). The pest is often a lesser problem in natural forests where Honduras mahoganies are more scattered. The mahogany webworm (*Macalla thyrsisalis* Walker), which occurs throughout the native range of Honduras mahogany, can cause defoliation and unsightly webbing (*27*). *Phyllosticta swietenie* Garcia, a leaf necrosis reported in Puerto Rico, can be serious in crowded nursery beds that are watered in late afternoon and remain wet at night. *Cercospora subsessilis* Syd. Whidi, which causes a leaf spot disease, has been reported in numerous areas. Also, numerous leaf diseases, cankers, root rots, heart rots, and mistletoes have been reported in plantations outside the natural range (*21*).

The sapwood of Honduras mahogany logs is vulnerable to attack by ambrosia beetles (numerous species of several genera) and subsequent discoloration if not quickly protected (*37*). The dry sapwood, and even the heartwood, is very attractive to powderpost beetles (*Lyctus* spp.) (authors, personal observation). Tests have shown that the heartwood is susceptible to attack by dry-wood termites, *Cryptotermes brevis* (Walker) (*71*), but in actual use in termite-infested areas, this wood is seldom attacked (*37*). Honduras mahogany has shown little resistance to marine borers (*Teredo* spp.) in either Hawaiian (*17, 37*) or Atlantic waters. The wood is resistant to decay when exposed and when in contact with the ground. Tests of plantation-grown wood showed it resistant to white-rot fungi and very resistant to brown-rot fungi in culture tests (*15*). Sawn wood weathers well and checks and warps little when exposed to the elements (10).

SPECIAL USES

Honduras mahogany is considered by many to be the world's premier cabinet wood (*36, 51*) and is deserving of the reputation for several reasons. Its red to yellow heartwood seasons to a rich reddish brown or golden brown with a fine luster. The sapwood is white to yellow, 2.5 to 5.0 cm thick, and of much lower value. The wood texture is fine to coarse, the grain straight or wavy, and often has an attractive figure, especially when quarter sawn (*12, 37*). Honduras mahogany wood can be air- or kiln-dried rapidly without warp or checking. Shrinkage of lumber (green to air-dried) sawn from forest-grown trees is 3.5-percent radial, 4.8-percent tangential, and 7.7-percent volumetric (*65*). Specific gravity of ovendried Honduras mahogany varies from 0.40 to 0.68 g/cm^3 (*12*). Strength properties are also variable. Wood with a specific gravity of 0.44 g/cm^3 from Belize demonstrated a modulus of rupture of 83 Newtons/mm^2, a maximum compression strength of 44.2 Newtons/mm^2, and a side hardness of 3,110 Newtons (*34*). Plantation-grown wood is usually a little lighter, softer, and weaker than forest-grown wood (*65*). Honduras mahogany is easy to work with hand and power tools. However, chipped or torn grain is common with figured material (*12*). The wood is easy to glue, holds nails and screws well, and takes an excellent polish (*37*). Honduras mahogany wood is used extensively in the manufacture of furniture, cabinets, trim, and paneling. Lesser quantities are used in arts and crafts, caskets, turnery, musical instruments (particularly pianos), and in shipbuilding (*12, 37*). Lower grade material is used for lumber, boxes, and fuel. The bark has a high tannin content (*36*).

Honduras mahogany is widely planted as both an ornamental and a shade tree. It has the advantages of rapid growth, tolerance of drought and poor soils, and dark-green foliage, but its roots eventually damage sidewalks and curbs if planted in close proximity. Honduras mahogany trees often suffer windthrow and breakage in hurricane-force winds (*55*).

GENETICS

The genus *Swietenia* is currently divided into three species, *S. macrophylla, S. mahagoni* Jacq., and *S. humilis* Zucc. (*48*). However, it has been suggested that *S. macrophylla* and *S. humilis* may be ecotypes of the same species (*69*). Chromosome numbers for the three species are 2n = 48 (*S. mahagoni*), 2n = 54 (*S. macrophylla*), and 2n = 56 (*S. humilis*) (*60*).

The *Swietenia* species freely hybridize. A spontaneous hybrid between *S. macrophylla* and *S. mahagoni* was found growing in Puerto Rico in 1935, with traits more or less midway between the two parent species (*69*). The F2 generation is reported to segregate into the parent species and the hybrid, according to the Mendelian ratio of 1:2:1 (*41*). Despite considerable variability, the hybrid has become important in forest plantings in the region.

Variability sufficient to justify selection and breeding programs apparently exists in Honduras mahogany. Random sampling of plantation trees showed phenotypic variation in bolewood specific gravity ranging from 0.36 to 0.65 g/cm^3 (*5*). Bolewood also varies significantly between geographic

sources (*4*). Wood density does not appear to be a strongly inherited trait. Although wood densities varied considerably between trees, no relationship could be established between wood densities of mother trees from a number of provenances and their open-pollinated progeny (*13*). Other important characters demonstrating variation among seed sources were: survival after planting, growth rate, flowering time, and capsule size (*20*).

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